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Sugarcane in monoculture or in rotation with sweet corn

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Abstract

Farmers in many regions of the world grow a horticultural or grain crop between sugarcane (a complex hybrid of *Saccharum* spp.) cycles. This additional crop often requires higher amounts of P or K fertilizers than does sugarcane. Some sugarcane growers in Florida precede 2- to 5-year cycles of sugarcane with one crop of spring-harvested sweet corn (*Zea mays* L.). A disadvantage perceived with this rotation is that the higher amounts of P fertilizer applied to sweet corn may reduce sugar yields of sugarcane. The primary objective of this study was to compare the sugarcane yields of a sugarcane and sweet corn rotation with those of monocropped sugarcane. Phosphorus and K fertilizers were also added to sugarcane at different rates in each rotation to form four cropping practices. Responses of four sugarcane cultivars were also tested among these cropping practices. Sugarcane experiments were conducted at three diverse field locations. Each location was harvested twice, first in the plant crop and about 1 year later in the first-ratoon crop. At least one cropping practice including sweet corn at each location had sugar yields (t sugar/ha) comparable to those of the highest monocropped sugarcane yields. Responses to cropping practices differed by location. Also, cultivars responded differently to cropping practices. By determining location-specific sugarcane fertilizers and cultivars, growers can grow sweet corn and sugarcane in rotation without reducing sugar yields of sugarcane. More research to determine appropriate cultivars and fertilizer rates could probably improve yields of sugarcane subjected to the sugarcane–sweet corn rotation and its residual fertilizers.

Key words: Cropping system; Rotation; *Saccharum*; Sugarcane

1. Introduction

Growers in Florida harvest sugarcane annually for 2 to 5 years before replanting. They replant most fields after 2 or 3 harvests. After the final harvest, many growers plant a new crop of sugarcane within 1 or 2 months. This is monocropped sugarcane planted in a successive system. Another option is to leave fields fallow for 6 to 12 months before replanting sugarcane. This is monocropped sugarcane planted in a fallow system. An extra crop of sugarcane is harvested in the successive system compared to the fallow system. However, successively planted sugarcane normally has lower sugar yields (t sugar/ha/year) than sugarcane planted in the fallow system.

An alternate cropping system is to plant sweet corn, from January through March, after the last-ratoon harvest of sugarcane. This simulates the intensive land use of the successive sugarcane system by replacing one year of sugarcane with sweet corn. In addition, this rotation retains many of the benefits of the fallow system because it leaves the land idle for 3 to 6 months

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after harvesting sweet corn and before planting sugarcane. Theoretically, this system can produce as many harvests (corn and sugarcane) as a successive system (sugarcane only) but with the annual sugarcane yields of a fallow system.

The major disadvantage perceived with such a cropping system is that growers apply more P fertilizer to sweet corn than to one crop of sugarcane (Gascho and Kidder, 1979; Hochmuth, 1990; Sanchez, 1990). The effects on sugarcane of the residual P applied to sweet corn are not known. Sugarcane and sweet corn in south Florida require similar rates of K fertilization (Sanchez, 1990). However, we do not know if the residual K applied to sweet corn affects a subsequent sugarcane crop.

Sugarcane growers in several regions of the world face similar crop rotation issues. Workers in Mauritius reported that N from a previous maize crop had no effect on a subsequent sugarcane crop (Anonymous, 1991). Mendoza et al. (1988) found that intercropping mungbean with sugarcane allowed them to reduce N fertilizer rates in sugarcane ratoon crops without reducing yields. Regarding more fixed nutrients such as P and K, Imam et al. (1990) reported positive effects on sugarcane of residual P and K from potato intercropped with sugarcane in Bangladesh. Sundara and Subramanian (1989) advised using the recommended monoculture nutrient levels for each crop they tested in various cropping systems in India.

Previous work in Florida has shown that high rates of fertilizer P can decrease sugar yields (Neller, 1942; le Grand and Thomas, 1963). In Texas, Thomas and Rozeff (1988) reported that sugar yields declined with high rates of K fertilizer. Thus, growers are concerned that the residual fertilizers of the sweet corn may reduce sugarcane yields even though they are applied to sweet corn 8 to 9 months before planting sugarcane.

Other reports suggest that nutrients applied to sweet corn may not reduce sugarcane yields. In Texas, Thomas et al. (1985) reported that sugarcane did not respond positively or negatively to increased levels of P fertilizer. In Florida, Gascho and Kidder (1979) reported that P fertilizer from rates of 0 to 100 kg/ha increased sugar yields for a three-crop cycle, plant crop through second-ratoon crop, of sugarcane. At rates above 100 kg/ha, yields leveled but did not decline. The same study reported that increasing rates of K did not affect sugar/ha yields. However, increasing rates of P or K caused sugar concentration (kg sugar/t cane) to decrease and cane yields (t/ha) to increase.

The primary objective of this study was to compare the sugarcane yields of a sugarcane and sweet corn rotation with the yields of monocropped sugarcane. Treatment variables were applied only to sugarcane. An additional objective was to determine if sugarcane cultivars interacted significantly with cropping practices. Two minor objectives were to compare no added P with recommended rates of P for monocropped sugarcane planted in the fallow system, and also, no added K with recommended rates of K for sugarcane planted after sweet corn.

2. Materials and methods

Experiments with sugarcane were planted in 1986 at three locations on Florida Histosols classified as euic, hyperthermic Lithic Medisaprists. The planting dates were 3 and 4 October at location 1, 15 October at location 2, and 17 November at location 3. The sugarcane in the experiments was harvested twice at each location. At location 1, the plant crop was harvested on 28 February 1988 and the first-ratoon crop on 6 March 1989. At location 2, the two harvest dates were 2 March 1988 and 5 December 1988. The location 3 harvests occurred on 7 and 8 January 1988 and 29 November 1988.

Each experiment was a 4×4 factorial with three replications in a randomized complete block design with treatments arranged as split plots. Four cropping practices comprised the main plots. These four practices were: (1) sugarcane following sweet corn with no fertilizer applied to the sugarcane (AC-0-0, AC for "After Corn" and 0-0 for no P or K fertilizers, respectively); (2) sugarcane following sweet corn with K applied to the sugarcane (AC-0-K); (3) monocropped sugarcane (MS) with K fertilizer (MS-0-K); and (4) monocropped sugarcane with K and P fertilizers (MS-P-K).

All AC plots received P and K fertilizers at recommended rates when they were commercially planted to sweet corn between January and March 1986. The rates of these fertilizers were 79 kg/ha P and 186 kg/ha K at location 1, 68 kg/ha P and 186 kg/ha K at location 2, and 40 kg/ha P and 206 kg/ha K at location 3. After the sweet corn was harvested and plowed under from

March 1986 to June 1986, all AC plots were left fallow and not flooded. All MS plots were left fallow and not flooded after sugarcane was harvested and plowed out late in 1985 or early in 1986.

When planting sugarcane in 1986, all fertilizers were applied by hand and placed in the furrows. Micronutrients were applied at their recommended rates. Phosphorus and K fertilizers were applied at the rates shown in Table 1. In May 1987, we applied P and K fertilizers by hand between the rows to the first-ratoon crop at the rates shown in Table 1.

Four sugarcane cultivars, CP 70-1133, CP 72-1210, CP 72-2086, and CP 74-2005 comprised the subplots. All subplots contained four rows 10.7 m long with 1.5 m between rows. No border rows separated subplots. Main plots consisted of four subplots and were 16 rows wide. An alley of 1.5 m separated the end of each main plot from the beginning of the next main plot. Because fertilizers were applied to main plots, nutrient feeding of roots across subplots or nutrient movement across subplots probably did not confound results (Coale and Sanchez, 1990).

The most practical procedure of establishing AC and MS plots was to plant them on separate fields. To minimize the effects of lack of randomization for AC and MS treatments, locations were chosen carefully. Each location had two fields separated only by a field ditch.

Table 1
Phosphorus and K fertilizer rates of four treatments in the plant and first-ratoon crops at three locations

Treatment	Location	Fertilizer applied			
		Plant crop		First-ratoon crop	
		P (kg/ha)	K (kg/ha)	P (kg/ha)	K (kg/ha)
AC-0-0	1	0	0	0	0
AC-0-K	1	0	121	0	140
MS-0-K	1	0	121	0	140
MS-P-K	1	28	193	20	140
AC-0-0	2	0	0	0	0
AC-0-K	2	0	121	0	140
MS-0-K	2	0	121	0	140
MS-P-K	2	28	193	20	140
AC-0-0	3	0	0	0	0
AC-0-K	3	0	153	0	140
MS-0-K	3	0	153	0	140
MS-P-K	3	18	153	20	140

One side of the ditch had been cropped to sweet corn while the opposite side was left fallow following sugarcane. Pairs of fields had similar soil analyses and yield histories before applying the sweet-corn fertilizers. Thus, at each location, all AC treatments were on one side of the field ditch and all MS treatments were on the other side. Otherwise, all treatments were randomized.

Each of the three locations represented distinct environmental zones of sugarcane production and soil pH, P, and K levels. Location 1 was closest to the moderating environmental effects of Lake Okeechobee, and location 3 was farthest from the lake. Soil samples of 8 cores per subplot, each 19 cm deep, were taken soon after planting sugarcane. Soil samples were taken between furrows to eliminate effects of the recently applied fertilizers. Soil samples were analyzed for P, K, and pH (Table 2) according to procedures described by Sanchez (1990).

At each harvest, laborers cut all four rows of cane from each subplot. This cut cane was weighed with a tractor-mounted weighing device, and cane yield (t cane/ha) was calculated from this weight. Fifteen full-length stalks randomly selected from each subplot comprised the samples used for milling and crusher juice analysis. The theoretical sugar concentration (kg sugar/t cane) was calculated from the Brix and polarity of each sample using a previously described procedure (Arceneaux, 1935). The product of cane yield and sugar concentration divided by 1000 equaled sugar yield (t sugar/ha).

Analyses of variance were calculated with MSTAT (Freed et al., 1988) for a "Two factor randomized complete block design with split, combined over loca-

Table 2
Soil tests under two cropping systems at three locations

Location	Cropping system	pH	P (kg/ha)	K (kg/ha)
1	AC	7.9	9.5	83.6
1	MS	7.7	3.8	82.6
2	AC	6.6	7.8	151.8
2	MS	6.6	4.1	130.3
3	AC	5.4	13.8	98.3
3	MS	5.3	8.8	54.6
$LSD_{(0.05)}$ Location		0.8	1.7	15.8
$LSD_{0.05)}$ Crop sys.		0.2	1.0	7.9

tions and years, same location and randomization each year.'' Analyses of variance for separate locations were also calculated with MSTAT. Significant F and LSD values were sought at $P \leqslant 0.05$.

3. Results and discussion

The location × cropping practice interactions were highly significant for sugar yield and both of its yield components (Table 3). Therefore, effects of these treatments differed by location.

At location 1, the cropping practices that included sweet corn negatively affected sugar concentration, and positively affected cane yield compared to the MS system (Table 4). The AC-0-0 and AC-0-K treatments had similar sugar concentrations and similar cane yields. Also, the two MS fertilizer treatments had similar sugar concentrations and cane yields. Therefore, supplemental K fertilizer in the AC system, as well as supplemental P fertilizer in the MS system, did not affect sugar or cane yields. These results conflict with those of Sanchez (1990) which recommended supplemental P fertilizers in the MS plots and supplemental K fertilizers in the AC and MS plots for soils similar to those of location 1 (Table 2).

Table 3
Analysis of variance, combined across crops and locations for sugar yield and its two yield components

Source	d.f.	P>F		
		Sugar conc.	Cane yield	Sugar yield
Location (L)	2	<0.01	<0.01	<0.01
Crop year (C)	1	<0.01	<0.01	<0.01
L×C	2	<0.01	<0.01	<0.01
Crop practice (A)	3	<0.01	0.05	0.90
L×A	6	<0.01	<0.01	<0.01
C×A	3	0.02	0.11	0.07
L×C×A	6	0.88	0.21	0.37
Cultivar (B)	3	<0.01	<0.01	<0.01
L×B	6	<0.01	<0.01	<0.01
C×B	3	<0.01	<0.01	<0.01
L×C×B	6	0.01	<0.01	<0.01
A×B	9	0.03	0.02	0.01
L×A×B	18	0.28	0.82	0.81
C×A×B	9	0.10	0.54	0.41
C×L×A×B	18	0.87	0.95	0.88
Source	d.f.	Error mean squares		
		Sugar conc. $(kg/t)^2$	Cane yield $(t/ha)^2$	Sugar yield $(t/ha)^2$
Rep/L	6	36.0	114.5	1.61
Rep×C/L	6	14.1	48.8	1.16
Error A	36	35.1	80.4	1.69
Error B	144	32.5	91.6	1.82

Table 4
Combined yields across cultivars and crops of cropping practices at three locations

Cropping practice	Location	Sugar conc. (kg/t)	Cane yield (t/ha)	Sugar yield (t/ha)
AC-0-0	1	132.7	117.6	15.44
AC-0-K	1	132.9	115.3	15.15
MS-0-K	1	140.5	103.4	14.30
MS-P-K	1	140.5	106.8	14.84
$LSD_{(0.05)}$	1	6.0	10.2	1.32
AC-0-0	2	125.3	105.4	13.14
AC-0-K	2	121.8	107.7	13.02
MS-0-K	2	123.9	109.3	13.49
MS-P-K	2	124.1	109.9	13.59
$LSD_{(0.05)}$	2	3.4	3.9	1.23
AC-0-0	3	113.0	75.0	8.39
AC-0-K	3	111.0	84.0	9.27
MS-0-K	3	116.7	81.5	9.47
MS-P-K	3	108.9	81.9	8.87
$LSD_{(0.05)}$	3	3.8	9.1	1.23

The sugar yields of the four cropping-practice treatments at location 1 did not differ significantly (Table 4). Thus, the AC system did not reduce sugar yields. However, sugar concentrations declined and cane yields increased in the AC compared to the MS system. These changes in the yield components of sugar yield result in higher sugarcane harvesting and processing costs. Therefore, at location 1, the AC system was beneficial only to the extent that returns from sweet corn compensated for these increased costs.

Cropping practices did not differ significantly in sugar yield at location 2 (Table 4). However, supplemental K fertilizer applied to sugarcane after sweet corn reduced sugar concentration at this location. Conversely, the AC-0-0 treatments produced less cane yield than both MS cropping practices which contained K, whereas the AC-0-K treatment and the two MS treatments had similar cane yields. Since sugar yields were similar in both cases, the best option was to not apply K after sweet corn at location 2. The MS-0-K and MS-P-K treatments had similar yields for all three yield components (Table 4). Thus, P fertilizer in the MS system did not affect yields at location 2.

Sanchez (1990) recommended supplemental P fertilization for the MS plots at location 2 in the plant and first-ratoon crops, and for the AC plots only in the first-ratoon crop (Table 2). Our results suggest that this additional P does not benefit cane yields. Sanchez recommended K fertilization for the AC plots at location 2 only in first ratoon. Since we either applied or did not apply K in both the plant and first-ratoon crops, our K results at location 2 do not relate directly to those of Sanchez. However, his recommended approach would be the next logical experimental treatment for sugarcane following sweet corn at location 2.

The MS-0-K treatment yielded more sugar concentration at location 3 than did any other treatment ($P=0.056$) (Table 4). This was the only cropping-practice treatment that did not contain either residual or directly applied P. Thus, P fertilizer in the MS system decreased sugar concentration at location 3 (Table 4). Also, the AC system, perhaps due to its residual P, reduced sugar concentration. The AC-0-0 treatment had lower cane and sugar yields than the other three treatments at location 3 ($P=0.052$). The cane and sugar yields of the other three treatments did not differ significantly. This positive response to K in the AC plots agrees with the recommendations of Sanchez (1990) (Table 2).

Sanchez recommended supplemental P only for the first-ratoon crop in the MS plots at location 3. Our results did not test that recommendation directly. However, sugar concentration responded negatively to P without a coinciding positive response in cane yield. These results suggest reducing the recommended rate of P fertilizer for sugarcane on low pH soils similar to those of location 3. This conclusion is verified by Lucas (1982) who reported that organic soils at the lower end of the pH range of 4.9 to 7.5 had more soluble, available P.

The crop year × cropping practice interaction was significant for sugar concentration and almost significant for sugar yield (Table 3). Florida growers normally harvest 1 plant crop and 1 or 2 ratoon crops of sugarcane before replanting fields. These results suggest that growers will profit from specific plant-crop and ratoon-crop fertilizer programs for these cropping systems.

Potassium fertilizer management in the AC system was one cause of the significant crop year × cropping practice interaction. In the plant crop, K applied in the AC-0-K treatment had no effect on sugar yield or either of its components (Table 5). However, in the first-ratoon crop, AC-0-K had a significantly greater cane yield than did AC-0-0 (Table 5). Thus, application of K, both in the plant and first-ratoon crops in the AC system, raised first-ratoon but not plant-crop yields.

Table 5 supports reducing P fertilizers in the MS system. Averaged over all three locations in the plant crop, both MS treatments produced similar sugar concentrations, and cane and sugar yields. In first ratoon, MS-P-K yielded more cane than did MS-0-K. However, MS-0-K yielded more sugar concentration than did MS-P-K. Sugar yields between the two MS treatments did not differ significantly in first ratoon. Therefore, P fertilizer in the MS system did not affect sugar yields, but it increased cane yields and decreased sugar concentration. This topic needs further research for growers who harvest more than one ratoon crop. They may need to apply P fertilizer at least once in the sugarcane crop cycle. Also, they may find advantages to applying P in the plant crop and then not in the ratoon crops or vice versa.

Sugar yield, cane yield and sugar concentration had significant cultivar by cropping practice interactions (Table 3). Thus, cultivars did not react similarly to the

Table 5
Combined yields across locations and cultivars of plant (PC) and first-ratoon (1R) crops and cropping practices

Crop	Cropping practice	Sugar conc. (kg/t)	Cane yield (t/ha)	Sugar yield (t/ha)
PC	AC-0-0	117.7	111.5	13.37
PC	AC-0-K	115.8	111.9	13.11
PC	MS-0-K	122.9	110.1	13.62
PC	MS-P-K	121.1	108.7	13.34
1R	AC-0-0	129.6	87.2	11.28
1R	AC-0-K	128.9	92.6	11.85
1R	MS-0-K	133.3	86.1	11.22
1R	MS-P-K	129.2	90.4	11.53
$LSD_{(0.05)}$		2.8	4.3	0.62

cropping practices. Sugarcane growers should monitor cultivar responses to new cropping practices. A good cultivar in one system may have mediocre yields in another cropping system. These significant interactions support the premise that breeders could select cultivars adapted to low or high levels of specific nutrients. Successful selection of such varieties may become a priority in South Florida due to public concern over P in the water system.

When K was applied to CP 70-1133 in the AC system, sugar concentration dropped and cane yield increased ($P=0.07$) (Table 6). Phosphorus fertilizers adversely affected CP 74-2005 more than the other cultivars. This cultivar had lower sugar concentrations and sugar yields in the AC than in the MS treatments (Table 6). It had higher sugar concentration in MS-0-K than in any other treatment (Table 6). Only MS-0-K had neither residual P from sweet corn nor P directly applied to sugarcane. The cane yields did not differ for CP 74-2005 between the MS-P-K and MS-0-K treatments (Table 6). For some other treatments reported here, when an increase in P fertilizer caused a decrease

Table 6
Combined yields across locations and crops of four cultivars and four cropping practices

Cropping practice	Cultivar	Sugar conc. (kg/t)	Cane yield (t/ha)	Sugar yield (t/ha)
AC-0-0	CP 70-1133	119.5	126.3	15.15
AC-0-0	CP 72-1210	125.7	98.6	12.58
AC-0-0	CP 72-2086	124.6	95.2	11.93
AC-0-0	CP 74-2005	124.9	77.3	9.62
AC-0-K	CP 70-1133	114.7	132.1	15.15
AC-0-K	CP 72-1210	124.7	100.5	12.28
AC-0-K	CP 72-2086	124.9	100.8	12.74
AC-0-K	CP 74-2005	123.4	75.8	9.30
MS-0-K	CP 70-1133	122.1	124.0	15.09
MS-0-K	CP 72-1210	127.6	92.9	12.01
MS-0-K	CP 72-2086	125.7	93.2	11.76
MS-0-K	CP 74-2005	132.7	82.3	10.81
MS-P-K	CP 70-1133	119.6	125.6	15.13
MS-P-K	CP 72-1210	127.2	93.1	12.04
MS-P-K	CP 72-2086	123.2	99.7	12.35
MS-P-K	CP 74-2005	128.0	79.8	10.19
$LSD_{(0.05)}$		3.7	6.2	0.88

in sugar concentration, cane yield increased. Thus, CP 74-2005 was poorly adapted to the AC system and to P fertilizer in the MS system.

Cropping practices had no significant effect on the yields of CP 72-1210 and CP 72-2086 (Table 6). The latter had much lower sugar and cane yields than CP 70-1133. However, CP 72-2086 is more susceptible to pineapple disease (*Ceratocystis paradoxa* (Dade) C. Moreau) than is CP 70-1133 (Coale, 1989). In two of three locations in this study, CP 72-2086 had moderately reduced stands due to pineapple disease. Since stands of CP 72-2086 were similar across treatments, we are confident that pineapple disease did not affect treatment interactions.

4. Conclusions

The major objective of this project was to compare the sugarcane yields of a sweet corn and sugarcane rotation with those of monocropped sugarcane at three diverse field locations. It was concluded that growers at each location could use a cropping practice which included a crop of sweet corn between sugarcane cycles, and still obtain sugar yields equal to those of sugarcane in monoculture. A second objective was to compare sugarcane cultivar interactions with the cropping systems. It was found that cultivars reacted differently to cropping systems. Growers will need to choose cultivars carefully, according to their environments, to maximize yields with a sweet corn–sugarcane cropping system.

We did not propose to determine P and K recommendations for monocropped sugarcane or for sugarcane following sweet corn. However, the study raised questions regarding the currently recommended P and K fertilizer rates for sugarcane. Many sugarcane farmers rotate sugarcane with crops like sweet corn which require greater nutrient levels than sugarcane. Results from this study show that fertilizer recommendations based on monocropped sugarcane may not always be optimum in a two-crop rotation.

References

Anonymous, 1991. Mauritius Sugar Industry Research Institute, Annual Report 1990, p. 34.

Arceneaux, G., 1935. A simplified method of making theoretical sugar yield calculations. In accordance with the Winter–Carp–Geerligs formula. Int. Sugar J., 37: 264–265.

Coale, F.J., 1989. An integrated approach for control of pineapple disease of sugarcane. Sugarcane Growers Newsletter 3(4). Institute of Food and Agricultural Sciences, University of Florida.

Coale, F.J. and Sanchez, C.A., 1990. Effective distance of nutrient acquisition for sugarcane grown on Everglades Histosols. J. Am. Soc. Sugarcane Technol., 10: 39–44.

Freed, R., Eisensmith, S.P., Goetz, S., Reicosky, D., Smail, V.W. and Wolberg, P., 1988. Users Guide to MSTAT-C. Michigan State University.

Gascho, G.J. and Kidder, G., 1979. Responses to phosphorus and potassium and fertilizer recommendations for sugarcane in South Florida. Florida Agriculture Experiment Station Bulletin 809 (technical).

Hochmuth, G., 1990. Fertilizer management for sweet corn in Florida. In: W.M. Stall and D.N. Maynard (Coordinators), Sweet Corn Institute SS VEC 004. Institute of Food and Agricultural Sciences, University of Florida, pp. 32–34.

Imam, S.A., Hossain, A., Sikka, L.C., Midmore, D.J. and Delwar, H., 1990. Agronomic management of potato/sugarcane intercropping and its economic implications. Field Crops Res., 25: 1–2, 111–122.

le Grand, F. and Thomas, F.H., 1963. Influence of phosphorus and sulfur applications on the growth and chemical analysis of sugarcane growing on organic soils. Everglades Station Mimeo Report, EES 64-13.

Lucas, R.E., 1982. Organic soils (Histosols). Formation, distribution, physical and chemical properties and management for crop production. Research Report 435, Michigan State University.

Mendoza, T.C., Bergonia, E.B., Celestino, E.C. and Andam, C.J., 1988. Enhancing sugar yield through intercropping *Rhizobium* inoculated legume. Philippine Technol. J., 13: 20–30.

Neller, J.R., 1942. A comparison of different sources of phosphorus for use on Everglades peat. Soil Science Society Florida, Proceedings IV-B: 55–60.

Sanchez, C.A., 1990. Soil testing and fertilizer recommendations for crop production on organic soils in Florida. Institute of Food and Agricultural Sciences, University of Florida Bulletin 876, Gainesville, FL.

Sundara, B. and Subramanian, S., 1989. Fitting short duration sugarcane into cropping systems: yield and quality of short duration sugarcane as influenced by row spacing and nitrogen levels in different sequences. Madras Agric. J., 75: 124–134.

Thomas, J.R. and Rozeff, N., 1988. Investigation of potassium needs of sugarcane in Texas. J. Am. Soc. Sugarcane Technol., 8: 38–43.

Thomas, J.R., Scott, Jr., A.W. and Wiedenfeld, R.P., 1985. Fertilizer requirements of sugarcane in Texas. J. Am. Soc. Sugarcane Technol., 4: 62–72.